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## (54) ALUMINUM ALLOY-MADE HEAT EXCHANGER AND ITS MANUFACTURE

(57)Abstract:

PURPOSE: To obtain an aluminum alloy-made heat exchanger having excellent joining strength between a tube material and a fin and corrosion resistance by thermal-spraying the specific alloy containing Bi as a brazing filler metal on the surface of the tube material and applying a flux brazing or an atmospheric brazing after assembling the bear fins of a specific aluminum alloy.

CONSTITUTION: After thermal-spraying Zn on the surface, the aluminum alloy- made bear fins are joined to the aluminum alloy-made tube material having the film thermal-spraying the brazing filler metal by the flux brazing or the atmospheric

brazing. The alloy composition of the brazing filler metal is the Al alloy composed of 6–13wt% Si, 0.1–0.5% Bi and the balance Al with inevitable impurities. Further, the alloy composition of the bear fin is the Al alloy composed of 0.5–5wt% Mn and the balance Al with inevitable impurities or the Al alloy composed of 0.5–5wt.% Mn, 0.5–8% Zn and the balance Al with inevitable impurities.

## CLAIMS

[Claim(s)]

[Claim 1]After carrying out thermal spraying of the Zn to the surface, to a tube material which consists of aluminum or an aluminum alloy which has the coat which carried out thermal spraying of the wax material. It is the aluminum alloy made heat exchanger which joined BEAFIN which consists of aluminum alloys by flux brazing or atmosphere brazing, Alloy composition of wax material Si:6 - 13wt% and Bi:0.1 - 0.5wt%, The remainder is an aluminum alloy which consists of aluminum and unescapable non-purity, An aluminum alloy in which the remainder consists of aluminum and unescapable non-purity Mn:0.5 - 5wt% in aluminum alloy composition of BEAFIN, Or an aluminum alloy made heat exchanger characterized by the remainder being an aluminum alloy which consists of aluminum and unescapable non-purity Zn:0.5 - 8wt% Mn:0.5 - 5wt%.

[Claim 2]To a tube material which consists of aluminum or an aluminum alloy which has the coat which carried out thermal spraying of the wax material to the surface. It is the aluminum alloy made heat exchanger which joined BEAFIN which consists of aluminum alloys by flux brazing or atmosphere brazing, Alloy composition of wax material Si:6 - 13wt% and Zn:0.5 - 8wt%, Bi:0.1 - 0.5wt% and the remainder are the aluminum alloys which consist of aluminum and unescapable non-purity, An aluminum alloy in which the remainder consists of aluminum and unescapable non-purity Mn:0.5 - 5wt% in aluminum alloy composition of BEAFIN, Or an aluminum alloy made heat exchanger characterized by the remainder being an aluminum alloy which consists of aluminum and unescapable non-purity Zn:0.5 - 8wt% Mn:0.5 - 5wt%.

[Claim 3]After carrying out thermal spraying of the Zn to the surface of a tube which consists of aluminum or an aluminum alloy, Alloy composition carries out thermal spraying of the wax material which consists of an aluminum alloy in which the remainder consists of aluminum and unescapable non-purity Bi:0.1 - 0.5wt% Si:6 - 13wt%, An aluminum alloy whose alloy composition is Mn:0.5 - 5wt% and whose remainders are aluminum and unescapable non-purity, Or a manufacturing method of an aluminum alloy made heat exchanger, wherein the remainder brazed [ flux-] or brazed [ atmosphere-] after ****** BEAFIN which consists of an aluminum alloy which are aluminum and unescapable non-purity and joins Zn:0.5 - 8wt% Mn:0.5 - 5wt%.

[Claim 4]Alloy composition on the surface of a tube which consists of aluminum or an aluminum alloy Si:6 - 13wt%, The remainder carries out thermal spraying of the wax material which consists of an aluminum alloy which consists of aluminum and

unescapable non-purity Bi:0.1 - 0.5wt% Zn:0.5 - 8wt%, An aluminum alloy whose alloy composition is Mn:0.5 - 5wt% and whose remainders are aluminum and unescapable non-purity, Or a manufacturing method of an aluminum alloy made heat exchanger, wherein the remainder brazed [ flux-] or brazed [ atmosphere-] after ****** BEAFIN which consists of an aluminum alloy which are aluminum and unescapable non-purity and joins Zn:0.5 - 8wt% Mn:0.5 - 5wt%.

[Translation done.]

## DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application]This invention is a thing about the aluminum alloy made heat exchanger manufactured by the flux brazing method or atmosphere brazing.
The aluminum alloy made heat exchanger of this invention is widely applied to the heat exchanger for car air conditioners, an industrial heat exchanger, etc.

[0002]

[Description of the Prior Art]The conventional aluminum alloy made heat exchanger to the tube material which consists of raise in basic wages material of aluminum (JISA1050, JIS A1100) or an aluminum alloy (aluminum-Mn) by which extrusion molding was carried out. Make aluminum-Mn alloy into a core material, use an aluminum-6 to 15%Si-0.5 to 3% Mg alloy, or an aluminum-7 to 15% Si alloy for wax material, and both are cold-rolled between heat from a clad sheet, It was considered as the brazing sheet, the fabrication of the fin material which consists of a tube which carried out Zn thermal spraying, and a brazing sheet was carried out, and the back with a group had joined between headers to the tube of an aluminum alloy, and between fins and a tube by the flux brazing method or atmosphere brazing with the jig.

[0003]However, since a fin is the brazing sheet in which the clad of the high aluminum-Si-Mg alloy or aluminum-Si-Mg-Zn alloy of hardness was carried out to the surface in this conventional method, In the rolling process, especially cold rolling process from an ingot clad sheet of a brazing sheet, wear of a reduction roll is intense, and. When processing a brazing sheet into the fin of a heat exchanger, the abrasion life of the louver cutter which carries out shearing of the louver formed in a fin is dramatically short, and the manufacturing cost of an aluminum alloy made heat exchanger becomes high.

[0004]The coat of the aluminum-Zn-Si alloy of a specific range is formed in the surface of the tube of aluminum or an aluminum alloy, the fin which does not have wax material is attached and the manufacturing method of the heat exchanger made of aluminum which carries out flux brazing is known (JP,H1-107961,A).

[0005]However, in this conventional technology, since the wettability of wax material and mobility were not enough, there was a problem that the intensity of junction ran short a little.

[0006]

[Problem(s) to be Solved by the Invention]This invention is made that the problem of the above-mentioned conventional technology should be canceled, and the purpose of this invention, The life of the reduction roll in the rolling process from the ingot clad sheet of a brazing sheet is developed, It is providing the aluminum alloy made heat exchanger which reduced the manufacturing cost of the aluminum alloy made heat exchanger, and was excellent in a tube material, the bonding strength of a fin, and corrosion resistance by developing the abrasion life of the louver cutter which carries out shearing of the louver formed in a fin.

[0007]

[Means for Solving the Problem and its Function]This invention persons do thermal spraying of the specific alloy containing Bi to the tube material surface as wax material, as a result of repeating research wholeheartedly that an aforementioned problem should be solved, It finds out that what is necessary is for the back with a group just to flux-braze or atmosphere braze a fin which consists of raise in basic wages material of a specific aluminum alloy, and came to complete this invention.

[0008]After this invention carries out thermal spraying of the Zn to (1) surface, to namely, a tube material which consists of aluminum or an aluminum alloy which has the coat which carried out thermal spraying of the wax material. It is the aluminum alloy made heat exchanger which joined BEAFIN which consists of aluminum alloys by flux brazing or atmosphere brazing, Alloy composition of wax material Si:6 - 13wt% and Bi:0.1 - 0.5wt%, The remainder is an aluminum alloy which consists of aluminum and unescapable non-purity, An aluminum alloy in which the remainder consists of aluminum and unescapable non-purity Mn:0.5 - 5wt% in aluminum alloy composition of BEAFIN, Or an aluminum alloy made heat exchanger characterized by the remainder being an aluminum alloy which consists of aluminum and unescapable non-purity Zn:0.5 - 8wt% Mn:0.5 - 5wt%.

[0009](2) To a tube material which consists of aluminum or an aluminum alloy which has the coat which carried out thermal spraying of the wax material to the surface. It is the aluminum alloy made heat exchanger which joined BEAFIN which consists of aluminum alloys by flux brazing or atmosphere brazing, Alloy composition of wax material Si:6 - 13wt% and Zn:0.5 - 8wt%, Bi:0.1 - 0.5wt% and the remainder are the aluminum alloys which consist of aluminum and unescapable non-purity, An aluminum alloy in which the remainder consists of aluminum and unescapable non-purity Mn:0.5 - 5wt% in aluminum alloy composition of BEAFIN, Or an aluminum alloy made heat exchanger characterized by the remainder being an aluminum alloy which consists of aluminum and unescapable non-purity Zn:0.5 - 8wt% Mn:0.5 - 5wt%.

[0010](3) After carrying out thermal spraying of the Zn to the surface of a tube which consists of aluminum or an aluminum alloy, Alloy composition carries out thermal spraying of the wax material which consists of an aluminum alloy in which the remainder consists of aluminum and unescapable non-purity Bi:0.1 - 0.5wt% Si:6 - 13wt%, An aluminum alloy whose alloy composition is Mn:0.5 - 5wt% and whose remainders are aluminum and unescapable non-purity, Or a manufacturing method of an aluminum alloy made heat exchanger, wherein the remainder brazed [ flux-] or brazed [ atmosphere-] after ****** BEAFIN which consists of an aluminum alloy which are aluminum and unescapable non-purity and joins Zn:0.5 - 8wt% Mn:0.5 - 5wt%.
[0011](4) On the surface of a tube which consists of aluminum or an aluminum alloy. Alloy composition Si:6 - 13wt% and Zn:0.5 - 8wt% and Bi:0.1 - 0.5wt%, The remainder carries out thermal spraying of the wax material which consists of an aluminum alloy which consists of aluminum and unescapable non-purity, An aluminum alloy whose alloy composition is Mn:0.5 - 5wt% and whose remainders are aluminum and unescapable non-purity, Or a manufacturing method of an aluminum alloy made heat exchanger, wherein the remainder brazed [ flux-] or brazed [ atmosphere-] after ****** BEAFIN which consists of an aluminum alloy which are aluminum and unescapable non-purity and joins Zn:0.5 - 8wt% Mn:0.5 - 5wt%. It is considered as a gist.
[0012]In this invention, what is used as a tube material is not limited to these, although an aluminum alloy which added aluminum or Mn of JIS A1050 and JIS A1100 grade, etc. is mentioned. A tube is fabricated by an extrusion-molding method in aluminum or an aluminum alloy.
[0013]After this invention carries out thermal spraying of the Zn to the surface of a tube of extruded raise in basic wages material with a manufacturing method of a tube material, It is divided when carrying out thermal spraying of the wax material of an aluminum-Si-Zn-Bi alloy to a case where thermal spraying of the wax material of an aluminum-Si-Bi alloy is carried out, at once on the surface of a tube of (Claim 1, 3), and extruded raise in basic wages material (Claim 2, 4).
[0014]In order to carry out thermal spraying of the Zn to a tube, what is necessary is just to carry out thermal spraying immediately after extrusion of an extrusion flat tube of aluminum or an aluminum alloy, and preheating as thermal-spraying pretreatment is unnecessary. Any of flame spraying, high speed gas flame thermal spraying, and electric arc spraying may be sufficient as a thermal spraying method. Thermal spraying of Zn adjusts the amount of thermal spraying so that metsuke amount may become 5 - 20 $g/m^2$.

[0015]Since raise in basic wages material to which the clad of the wax material (hard aluminum-Si alloy) is not carried out is used for a fin material, wax material is made to cover with a spraying process on a tube in this invention. Wax material by which thermal spraying is carried out to the surface of a tube of aluminum or an aluminum alloy is an aluminum-Si-Bi alloy or an aluminum-Si-Bi-Zn alloy of a range specific as mentioned above, and an operation of each ingredient and the Reason for limitation of a blending ratio are as follows.

[0016]- Lower the melting point of SiAl, make mobility after melting good, and raise brazing nature. If it separates from 6wt% - 13wt% of a range, the melting point of aluminum-Si alloy will become high, and mobility after melting falls and brazing nature falls.

[0017]- Since the wettability of aluminum-Si alloy after Bi melting improves and the mobility of aluminum-Si-alloy wax material improves, brazing nature becomes good. 0. Since the wettability of wax material which consists of an aluminum-Si-alloy thermal spraying material, and mobility fall, it is not desirable less than [ 1wt% ]. Even if it adds exceeding 0.5wt%, the mobility of wax material and wettability which consist of an aluminum-Si-alloy thermal spraying material do not improve.

[0018]- Into Zn brazing heat cycle, it is spread on a surface of heat exchanger tubes, and form a zinc diffused layer very effective in pitting prevention of an aluminum alloy. 0. Since an excessive zinc diffused layer will be formed if a zinc diffused layer effective in corrosion prevention is not formed enough but adds exceeding 8wt%, and an anticorrosion life of a heat exchanger falls on the contrary, it is not desirable less than [ 5wt% ].

[0019]As a thermal spraying method of wax material to a tube (extrusion flattened tube), Although there is a two-way-type method which carries out thermal spraying of the Bi alloy to a tube extruded in pure Zn with a method of carrying out thermal spraying of the Bi alloy aluminum-8 to 13%Si-0.1 to 0.5% further after thermal spraying once to a tube extruded from an extrusion machine aluminum-8 to 13%Si-0.5 to 8%Zn-0.1 to 0.5%, All are effective.

[0020]Methods of carrying out thermal spraying of the wax material to BEAFIN may include a method of carrying out thermal spraying of the above-mentioned after alloy powder, and a method of carrying out thermal spraying of the wire of the above-mentioned alloy, and any may be sufficient. Any of flame spraying, high speed gas flame thermal spraying, and electric arc spraying may be sufficient.

[0021]A fin used for this invention is the raise in basic wages material (nakedness material to which the clad of the wax material is not carried out) of aluminum-Mn alloy

## DETAILED DESCRIPTION

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[0001]

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[0014]In order to carry out thermal spraying of the Zn to a tube, what is necessary is just to carry out thermal spraying immediately after extrusion of an extrusion flat tube of aluminum or an aluminum alloy, and preheating as thermal-spraying pretreatment is unnecessary. Any of flame spraying, high speed gas flame thermal spraying, and electric arc spraying may be sufficient as a thermal spraying method. Thermal spraying of Zn adjusts the amount of thermal spraying so that metsuke amount may become 5 - 20 $g/m^2$.

[0015]Since raise in basic wages material to which the clad of the wax material (hard aluminum-Si alloy) is not carried out is used for a fin material, wax material is made to cover with a spraying process on a tube in this invention. Wax material by which thermal spraying is carried out to the surface of a tube of aluminum or an aluminum alloy is an aluminum-Si-Bi alloy or an aluminum-Si-Bi-Zn alloy of a range specific as mentioned above, and an operation of each ingredient and the Reason for limitation of a blending ratio are as follows.

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[0017]- Since the wettability of aluminum-Si alloy after Bi melting improves and the mobility of aluminum-Si-alloy wax material improves, brazing nature becomes good. 0. Since the wettability of wax material which consists of an aluminum-Si-alloy thermal spraying material, and mobility fall, it is not desirable less than [ 1wt% ]. Even if it adds exceeding 0.5wt%, the mobility of wax material and wettability which consist of an aluminum-Si-alloy thermal spraying material do not improve.

[0018]- Into Zn brazing heat cycle, it is spread on a surface of heat exchanger tubes, and form a zinc diffused layer very effective in pitting prevention of an aluminum alloy. 0. Since an excessive zinc diffused layer will be formed if a zinc diffused layer effective in corrosion prevention is not formed enough but adds exceeding 8wt%, and an anticorrosion life of a heat exchanger falls on the contrary, it is not desirable less than [ 5wt% ].

[0019]As a thermal spraying method of wax material to a tube (extrusion flattened tube), Although there is a two-way-type method which carries out thermal spraying of the Bi alloy to a tube extruded in pure Zn with a method of carrying out thermal spraying of the Bi alloy aluminum-8 to 13%Si-0.1 to 0.5% further after thermal spraying once to a tube extruded from an extrusion machine aluminum-8 to 13%Si-0.5 to 8%Zn-0.1 to 0.5%, All are effective.

[0020]Methods of carrying out thermal spraying of the wax material to BEAFIN may include a method of carrying out thermal spraying of the above-mentioned after alloy powder, and a method of carrying out thermal spraying of the wire of the above-mentioned alloy, and any may be sufficient. Any of flame spraying, high speed gas flame thermal spraying, and electric arc spraying may be sufficient.

[0021]A fin used for this invention is the raise in basic wages material (nakedness material to which the clad of the wax material is not carried out) of aluminum-Mn alloy

or an aluminum-Mn-Zn alloy. An operation of an ingredient of an aluminum alloy of BEAFIN and the Reason for limitation of a blending ratio are as follows.

[0022]- Mn hardness and intensity improve and modification of a fin at the time of brazing heating can be prevented. 0. Since intensity will go up too much and a fabricating operation of a fin will become difficult if modification of a fin at the time of brazing heating cannot be prevented but it adds exceeding 5wt%, it is not desirable less than [ 5wt% ].

[0023]- Corrosion potential of Zn fin is lowered and there is an operation which carries out cathodic protection of the tube. 0. In order to carry out cathodic protection of the tube, even if it cannot be considered as potential of sufficient ** but adds exceeding 8wt%, potential of ** does not improve, but self-corrosion of a fin becomes intense, and it is not desirable less than [ 5wt% ].

[0024]Since wax material is raise in basic wages material by which a clad is not carried out, a fin of this invention is soft, and a life of a cold rolling roll of a manufacturing process of a brazing sheet used as a fin material is extended substantially, and. Since a life of a louver cutter used for louver shearing of a brazing sheet used as a fin material is extended substantially, a manufacturing cost can be lowered substantially.

[0025]BEAFIN with a thickness of 0.1-0.3 mm manufactured by cold rolling etc., A tube material and BEAFIN by which it was fabricated by fin configuration which has a louver with a louver cutter, and wax material was covered with the above-mentioned spraying process using a jig After [ with a group ], By the flux brazing method or the atmosphere brazing method, between headers is joined to a fin, and between tubes and a tube, and it is completed as an aluminum alloy made heat exchanger.

[0026]Flux used by flux brazing will not be limited especially if usually used, but fluoride systems, such as chloride systems, such as NaCl and KCl, $KAlF_4$, and $K_3AlF_6$, are mentioned, for example.

[0027]The atmosphere brazing method in this invention is among inert atmospheres, such as nitrogen gas and argon gas, a range of cooking temperature is 590-610 **, and the furnace pressure should just braze in the range of 0.1 - 760Torr.

[0028]The brazing temperature should just perform the flux brazing method and the atmosphere brazing method at 590-610 **, wax material fuses in response to a brazing thermal excursion, a fillet is formed between a tube, between fins and a tube, and a header, and junction is completed. Chemical conversion and resin coating processing are performed if needed after that.

[0029]When carrying out thermal spraying of the wax material of an aluminum-Si-Bi alloy after carrying out thermal spraying of the Zn to the surface of a tube of extruded

raise in basic wages material, into temperature up of a brazing process, Zn sprayed layers fuse, are diffused in a raise in basic wages tube material, and form an effective Zn diffused layer in a tube surface on corrosion prevention. When carrying out thermal spraying of the wax material of an aluminum-Si-Zn-Bi alloy to the surface of a tube of extruded raise in basic wages material at once, Zn in wax material is spread in a raise in basic wages fin material in a temperature rise process, and an effective Zn layer is formed on corrosion prevention.

[0030]An aluminum alloy made heat exchanger of this invention is applicable to a heat exchanger of the Serpentine type, a parallel flow type, a DORON cup (lamination) type, and other various form.

[0031]Hereafter, although working example explains this invention in detail, it is not limited to these working example.

[0032]

[Example]

In the 200-400 ** tube (extrusion flattened tube) just behind the extrusion of working example 1 pure aluminium (aluminum:99.9wt%). 10 g/$m^2$ thermal spraying carried out the pure Zn wire (1.6mmphi) with the arc spraying method, and metsuke amount 50 g/$m^2$ thermal spraying carried out the aluminum containing alloy wire which consists of aluminum-11%Si-0.3%Bi immediately after [ the ] with the arc spraying method.

[0033]Louver processing was carried out and the BEAFIN (aluminum-1%Mn-1%Zn) raw material created separately was attached with an above-mentioned tube and jig. After spray coating, it dried and the flux which becomes the attached heat exchanger material from the potash salt of aluminum fluoride was inserted in the NOKOROKKU brazing furnace.

[0034]From ordinary temperature to 605 **, temperature up of the brazing temperature pattern was carried out, and it was cooled after maintenance for 5 minutes. Into the temperature up of this brazing process, Zn sprayed layers fused, were diffused in the tube material (A1050), and formed the with the surface zinc concentration of 3%, and a diffusing depth of 120 micrometers zinc diffused layer. Compared with the tube core material (pure aluminum of A1050etc), the corrosion potential of this zinc diffused layer was **, and breakthrough foods were not generated at all in 5000 h of neutral salt spray tests at a 0.4-mm thick tube material, but it was very effective in pitting prevention of a tube.

[0035]Melting was started at 590 **, it is the brazing retention time for 605 **x 5 minutes, the fillet of sufficient size was formed on intensity between tube fins and between tube headers, and the wax piece of the brazing part did not generate wax

material (aluminum-Si-Bi in a thermal spraying material), either.

[0036]Electric arc spraying of the pure Zn wire (1.6mmphi) was carried out to the 200-400 ** tube just behind the extrusion of working example 2 pure aluminium (aluminum:99.9wt%), and thermal spraying of the powder (particle size undershirt of 70 micrometers) of a Bi alloy was further carried out to it by high speed gas flame thermal spraying aluminum-11%Si-0.3% after that.

[0037]The subsequent process manufactured the aluminum alloy made heat exchanger according to working example 1. Even if it did a 5000h neutral salt spray test, breakthrough foods were not generated at all in a 0.4-mm thick tube material.

[0038]Thermal spraying of the aluminum alloy wire (1.6mmphi) which becomes a 200-400 ** tube just behind the extrusion of working example 3 pure aluminium (aluminum:99.9wt%) from aluminum-11%Si-5%Zn-0.3%Bi was carried out by electric arc spraying.

[0039]The subsequent process manufactured the aluminum alloy made heat exchanger according to working example 1. Even if it did a 5000h neutral salt spray test, breakthrough foods were not generated at all in a 0.4-mm thick tube material.

[0040]Thermal spraying of (the particle size undershirt of 70 micrometers) was carried out for the aluminum alloy powder which becomes a 200-400 ** tube just behind the extrusion of working example 4 pure aluminium (aluminum:99.9wt%) from a Bi alloy aluminum-11%Si-5%Zn-0.3% by high speed gas flame thermal spraying.

[0041]The subsequent process manufactured the aluminum alloy made heat exchanger according to working example 1. Even if it did a 5000h neutral salt spray test, breakthrough foods were not generated at all in a 0.4-mm thick tube material.

[0042]Once having dried and preheating the tube material made from working example 5 aluminum alloy (extrusion flattened tube) with an arc and gas flame at 200-400 ** after water cooling, even if it performed above-mentioned working example 1-4, it checked that the completely same result was obtained.

[0043]The interval of regrinding by paper polish of a roll in the cold rolling process of each working example was extended several times, and it was admitted that the endurance of a roll was improving.

[0044]It was admitted that the endurance (hour of use until it discards) of the louver cutter in each working example was also extended several times.

[0045]

[Effect of the Invention]The aluminum alloy made heat exchanger of this invention has the following outstanding effects.

(1) Since Bi is contained in the wax material by which thermal spraying is carried out

on the surface of a tube material and the mobility of wax material and wettability are improved, fillet sufficient between tube fins and between tube headers is formed, and sufficient junction is made on intensity and pressure-proofing.

[0046](2) Diffuse Zn by which thermal spraying was carried out to BEAFIN, or Zn in wax material in a tube material by the thermal excursion in flux brazing or an atmosphere brazing process, and it forms the Zn diffused layer which has a preeminent effect in the corrosion-resistant improvement in a tube.

[0047](3) Since a fin is the soft raise in basic wages material of aluminum-Mn alloy or an aluminum-Mn-Zn alloy, wear of the reduction roll of the rolling process from an ingot, especially a cold rolling process is ****(ed) sharply, and an endurance life improves sharply, and. The endurance of the louver cutter at the time of louver processing of the heat-exchanger-fins material (0.1-0.3-mm thickness) which consists of brazing sheets can improve preeminently, and a manufacturing cost can be reduced.

[Translation done.]

## TECHNICAL FIELD

[Industrial Application]This invention is a thing about the aluminum alloy made heat exchanger manufactured by the flux brazing method or atmosphere brazing.
The aluminum alloy made heat exchanger of this invention is widely applied to the heat exchanger for car air conditioners, an industrial heat exchanger, etc.

[Translation done.]

## TECHNICAL FIELD

[Industrial Application]This invention is a thing about the aluminum alloy made heat exchanger manufactured by the flux brazing method or atmosphere brazing.
The aluminium alloy made heat exchanger of this invention is widely applied to the heat exchanger for car air conditioners, an industrial heat exchanger, etc.

[Translation done.]

## PRIOR ART

[Description of the Prior Art]The conventional aluminum alloy made heat exchanger to the tube material which consists of raise in basic wages material of aluminum (JISA1050, JIS A1100) or an aluminum alloy (aluminum-Mn) by which extrusion molding was carried out. Make aluminum-Mn alloy into a core material, use an aluminum-6 to 15%Si-0.5 to 3% Mg alloy, or an aluminum-7 to 15% Si alloy for wax material, and both are cold-rolled between heat from a clad sheet, It was considered as the brazing sheet, the fabrication of the fin material which consists of a tube which carried out Zn thermal spraying, and a brazing sheet was carried out, and the back with a group had joined between headers to the tube of an aluminum alloy, and between fins and a tube by the flux brazing method or atmosphere brazing with the jig.

[0003]However, since a fin is the brazing sheet in which the clad of the high aluminum-Si-Mg alloy or aluminum-Si-Mg-Zn alloy of hardness was carried out to the surface in this conventional method, In the rolling process, especially cold rolling process from an ingot clad sheet of a brazing sheet, wear of a reduction roll is intense, and. When processing a brazing sheet into the fin of a heat exchanger, the abrasion life of the louver cutter which carries out shearing of the louver formed in a fin is dramatically short, and the manufacturing cost of an aluminum alloy made heat exchanger becomes high.

[0004]The coat of the aluminum-Zn-Si alloy of a specific range is formed in the surface of the tube of aluminum or an aluminum alloy, the fin which does not have wax material is attached and the manufacturing method of the heat exchanger made of aluminum which carries out flux brazing is known (JP,H1-107961,A).

[0005]However, in this conventional technology, since the wettability of wax material and mobility were not enough, there was a problem that the intensity of junction ran short a little.

[Translation done.]

## EFFECT OF THE INVENTION

[Effect of the Invention]The aluminum alloy made heat exchanger of this invention has the following outstanding effects.

(1) Since Bi is contained in the wax material by which thermal spraying is carried out on the surface of a tube material and the mobility of wax material and wettability are improved, fillet sufficient between tube fins and between tube headers is formed, and sufficient junction is made on intensity and pressure-proofing.

[0046](2) Diffuse Zn by which thermal spraying was carried out to BEAFIN, or Zn in wax material in a tube material by the thermal excursion in flux brazing or an atmosphere brazing process, and it forms the Zn diffused layer which has a preeminent effect in the corrosion-resistant improvement in a tube.

[0047](3) Since a fin is the soft raise in basic wages material of aluminum-Mn alloy or an aluminum-Mn-Zn alloy, wear of the reduction roll of the rolling process from an ingot, especially a cold rolling process is ****(ed) sharply, and an endurance life improves sharply, and. The endurance of the louver cutter at the time of louver processing of the heat-exchanger-fins material (0.1-0.3-mm thickness) which consists of brazing sheets can improve preeminently, and a manufacturing cost can be reduced.

[Translation done.]

## TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention]This invention is made that the problem of the above-mentioned conventional technology should be canceled, and the purpose of this invention, The life of the reduction roll in the rolling process from the ingot clad sheet of a brazing sheet is developed, It is providing the aluminum alloy made heat exchanger which reduced the manufacturing cost of the aluminum alloy made heat exchanger, and was excellent in a tube material, the bonding strength of a fin, and corrosion resistance by developing the abrasion life of the louver cutter which carries out shearing of the louver formed in a fin.
[0007]

[Translation done.]

## OPERATION

[Means for Solving the Problem and its Function]This invention persons do thermal spraying of the specific alloy containing Bi to the tube material surface as wax material, as a result of repeating research wholeheartedly that an aforementioned problem should be solved, It finds out that what is necessary is for the back with a group just to flux-braze or atmosphere braze a fin which consists of raise in basic wages material of a specific aluminum alloy, and came to complete this invention.
[0008]After this invention carries out thermal spraying of the Zn to (1) surface, to namely, a tube material which consists of aluminum or an aluminum alloy which has the coat which carried out thermal spraying of the wax material. It is the aluminum alloy made heat exchanger which joined BEAFIN which consists of aluminum alloys by flux brazing or atmosphere brazing, Alloy composition of wax material is an aluminum alloy in which the remainder consists of aluminum and unescapable non-purity Bi:0.1 - 0.5wt% Si 6 - 13wt%.
An aluminum alloy in which the remainder consists of aluminum and unescapable non-purity Mn:0.5 - 5wt% in aluminum alloy composition of BEAFIN, Or an aluminum alloy made heat exchanger characterized by the remainder being an aluminum alloy which consists of aluminum and unescapable non-purity Zn:0.5 - 8wt% Mn:0.5 - 5wt%.

[0009](2) To a tube material which consists of aluminum or an aluminum alloy which has the coat which carried out thermal spraying of the wax material to the surface. It is the aluminum alloy made heat exchanger which joined BEAFIN which consists of aluminum alloys by flux brazing or atmosphere brazing, Alloy composition of wax material Si:6 - 13wt% and Zn:0.5 - 8wt%, Bi:0.1 - 0.5wt% and the remainder are the aluminum alloys which consist of aluminum and unescapable non-purity, An aluminum alloy in which the remainder consists of aluminum and unescapable non-purity Mn:0.5 - 5wt% in aluminum alloy composition of BEAFIN, Or an aluminum alloy made heat exchanger characterized by the remainder being an aluminum alloy which consists of aluminum and unescapable non-purity Zn:0.5 - 8wt% Mn:0.5 - 5wt%.
[0010](3) After carrying out thermal spraying of the Zn to the surface of a tube which consists of aluminum or an aluminum alloy, Alloy composition carries out thermal spraying of the wax material which consists of an aluminum alloy in which the remainder consists of aluminum and unescapable non-purity Bi:0.1 - 0.5wt% Si:6 - 13wt%, An aluminum alloy whose alloy composition is Mn:0.5 - 5wt% and whose remainders are aluminum and unescapable non-purity, Or a manufacturing method of

an aluminum alloy made heat exchanger, wherein the remainder brazed [ flux-] or brazed [ atmosphere-] after ****** BEAFIN which consists of an aluminum alloy which are aluminum and unescapable non-purity and joins Zn:0.5 - 8wt% Mn:0.5 - 5wt%.
[0011](4) On the surface of a tube which consists of aluminum or an aluminum alloy. Alloy composition Si:6 - 13wt% and Zn:0.5 - 8wt% and Bi:0.1 - 0.5wt%, The remainder carries out thermal spraying of the wax material which consists of an aluminum alloy which consists of aluminum and unescapable non-purity, An aluminum alloy whose alloy composition is Mn:0.5 - 5wt% and whose remainders are aluminum and unescapable non-purity, Or a manufacturing method of an aluminum alloy made heat exchanger, wherein the remainder brazed [ flux-] or brazed [ atmosphere-] after ****** BEAFIN which consists of an aluminum alloy which are aluminum and unescapable non-purity and joins Zn:0.5 - 8wt% Mn:0.5 - 5wt%. It is considered as a gist.
[0012]In this invention, what is used as a tube material is not limited to these, although an aluminum alloy which added aluminum or Mn of JIS A1050 and JIS A1100 grade, etc. is mentioned. A tube is fabricated by an extrusion-molding method in aluminum or an aluminum alloy.
[0013]After this invention carries out thermal spraying of the Zn to the surface of a tube of extruded raise in basic wages material with a manufacturing method of a tube material, It is divided when carrying out thermal spraying of the wax material of an aluminum-Si-Zn-Bi alloy to a case where thermal spraying of the wax material of an aluminum-Si-Bi alloy is carried out, at once on the surface of a tube of (Claim 1, 3), and extruded raise in basic wages material (Claim 2, 4).
[0014]In order to carry out thermal spraying of the Zn to a tube, what is necessary is just to carry out thermal spraying immediately after extrusion of an extrusion flat tube of aluminum or an aluminum alloy, and preheating as thermal-spraying pretreatment is unnecessary. Any of flame spraying, high speed gas flame thermal spraying, and electric arc spraying may be sufficient as a thermal spraying method. Thermal spraying of Zn adjusts the amount of thermal spraying so that metsuke amount may become 5 - 20 $g/m^2$.
[0015]Since raise in basic wages material to which the clad of the wax material (hard aluminum-Si alloy) is not carried out is used for a fin material, wax material is made to cover with a spraying process on a tube in this invention. Wax material by which thermal spraying is carried out to the surface of a tube of aluminum or an aluminum alloy is an aluminum-Si-Bi alloy or an aluminum-Si-Bi-Zn alloy of a range specific as mentioned above, and an operation of each ingredient and the Reason for limitation of

a blending ratio are as follows.

[0016]- Lower the melting point of SiAl, make mobility after melting good, and raise brazing nature. If it separates from 6wt% - 13wt% of a range, the melting point of aluminum-Si alloy will become high, and mobility after melting falls and brazing nature falls.

[0017]- Since the wettability of aluminum-Si alloy after Bi melting improves and the mobility of aluminum-Si-alloy wax material improves, brazing nature becomes good. 0. Since the wettability of wax material which consists of an aluminum-Si-alloy thermal spraying material, and mobility fall, it is not desirable less than [ 1wt% ]. Even if it adds exceeding 0.5wt%, the mobility of wax material and wettability which consist of an aluminum-Si-alloy thermal spraying material do not improve.

[0018]- Into Zn brazing heat cycle, it is spread on a surface of heat exchanger tubes, and form a zinc diffused layer very effective in pitting prevention of an aluminum alloy. 0. Since an excessive zinc diffused layer will be formed if a zinc diffused layer effective in corrosion prevention is not formed enough but adds exceeding 8wt%, and an anticorrosion life of a heat exchanger falls on the contrary, it is not desirable less than [ 5wt% ].

[0019]As a thermal spraying method of wax material to a tube (extrusion flattened tube), Although there is a two-way-type method which carries out thermal spraying of the Bi alloy to a tube extruded in pure Zn with a method of carrying out thermal spraying of the Bi alloy aluminum-8 to 13%Si-0.1 to 0.5% further after thermal spraying once to a tube extruded from an extrusion machine aluminum-8 to 13%Si-0.5 to 8%Zn-0.1 to 0.5%, All are effective.

[0020]Methods of carrying out thermal spraying of the wax material to BEAFIN may include a method of carrying out thermal spraying of the above-mentioned after alloy powder, and a method of carrying out thermal spraying of the wire of the above-mentioned alloy, and any may be sufficient. Any of flame spraying, high speed gas flame thermal spraying, and electric arc spraying may be sufficient.

[0021]A fin used for this invention is the raise in basic wages material (nakedness material to which the clad of the wax material is not carried out) of aluminum-Mn alloy or an aluminum-Mn-Zn alloy. An operation of an ingredient of an aluminum alloy of BEAFIN and the Reason for limitation of a blending ratio are as follows.

[0022]- Mn hardness and intensity improve and modification of a fin at the time of brazing heating can be prevented. 0. Since intensity will go up too much and a fabricating operation of a fin will become difficult if modification of a fin at the time of brazing heating cannot be prevented but it adds exceeding 5wt%, it is not desirable

less than [ 5wt% ].

[0023]- Corrosion potential of Zn fin is lowered and there is an operation which carries out cathodic protection of the tube. 0. In order to carry out cathodic protection of the tube, even if it cannot be considered as potential of sufficient ** but adds exceeding 8wt%, potential of ** does not improve, but self-corrosion of a fin becomes intense, and it is not desirable less than [ 5wt% ].

[0024]Sir ce wax material is raise in basic wages material by which a clad is not carried out, a fin of this invention is soft, and a life of a cold rolling roll of a manufacturing process of a brazing sheet used as a fin material is extended substantially, and. Since a life of a louver cutter used for louver shearing of a brazing sheet used as a fin material is extended substantially, a manufacturing cost can be lowered substantially.

[0025]BEAFIN with a thickness of 0.1-0.3 mm manufactured by cold rolling etc., A tube material and BEAFIN by which it was fabricated by fin configuration which has a louver with a louver cutter, and wax material was covered with the above-mentioned spraying process using a jig After [ with a group ], By the flux brazing method or the atmosphere brazing method, between headers is joined to a fin, and between tubes and a tube, and it is completed as an aluminum alloy made heat exchanger.

[0026]Flux used by flux brazing will not be limited especially if usually used, but fluoride systems, such as chloride systems, such as NaCl and KCl, $KAlF_4$, and $K_3AlF_6$, are mentioned, for example.

[0027]The atmosphere brazing method in this invention is among inert atmospheres, such as nitrogen gas and argon gas, a range of cooking temperature is 590-610 **, and the furnace pressure should just braze in the range of 0.1 - 760Torr.

[0028]The brazing temperature should just perform the flux brazing method and the atmosphere brazing method at 590-610 **, wax material fuses in response to a brazing thermal excursion, a fillet is formed between a tube, between fins and a tube, and a header, and junction is completed. Chemical conversion and resin coating processing are performed if needed after that.

[0029]When carrying out thermal spraying of the wax material of an aluminum-Si-Bi alloy after carrying out thermal spraying of the Zn to the surface of a tube of extruded raise in basic wages material, into temperature up of a brazing process, Zn sprayed layers fuse, are diffused in a raise in basic wages tube material, and form an effective Zn diffused layer in a tube surface on corrosion prevention. When carrying out thermal spraying of the wax material of an aluminum-Si-Zn-Bi alloy to the surface of a tube of extruded raise in basic wages material at once, Zn in wax material is spread in a raise in basic wages fin material in a temperature rise process, and an effective Zn layer is

formed on corrosion prevention.

[0030]An aluminum alloy made heat exchanger of this invention is applicable to a heat exchanger of the Serpentine type, a parallel flow type, a DORON cup (lamination) type, and other various form.

[0031]Hereafter, although working example explains this invention in detail, it is not limited to these working example.

[Translation done.]

EXAMPLE

[Example]

In the 200-400 ** tube (extrusion flattened tube) just behind the extrusion of working example 1 pure aluminium (aluminum:99.9wt%). 10 g/m$^2$ thermal spraying carried out the pure Zn wire (1.6mmphi) with the arc spraying method, and metsuke amount 50 g/m$^2$ thermal spraying carried out the aluminum containing alloy wire which consists of aluminum-11%Si-0.3%Bi immediately after [ the ] with the arc spraying method.

[0033]Louver processing was carried out and the BEAFIN (aluminum-1%Mn-1%Zn) raw material created separately was attached with an above-mentioned tube and jig. After spray coating, it dried and the flux which becomes the attached heat exchanger material from the potash salt of aluminum fluoride was inserted in the NOKOROKKU brazing furnace.

[0034]From ordinary temperature to 605 **, temperature up of the brazing temperature pattern was carried out, and it was cooled after maintenance for 5 minutes. Into the temperature up of this brazing process, Zn sprayed layers fused, were diffused in the tube material (A1050), and formed the with the surface zinc concentration of 3%, and a diffusing depth of 120 micrometers zinc diffused layer. Compared with the tube core material (pure aluminum of A1050etc), the corrosion potential of this zinc diffused layer was **, and breakthrough foods were not generated at all in 5000 h of neutral salt spray tests at a 0.4-mm thick tube material, but it was very effective in pitting prevention of a tube.

[0035]Melting was started at 590 **, it is the brazing retention time for 605 **x 5 minutes, the fillet of sufficient size was formed on intensity between tube fins and between tube headers, and the wax piece of the brazing part did not generate wax material (aluminum-Si-Bi in a thermal spraying material), either.

[0036]Electric arc spraying of the pure Zn wire (1.6mmphi) was carried out to the 200-400 ** tube just behind the extrusion of working example 2 pure aluminium (aluminum:99.9wt%), and thermal spraying of the powder (particle size undershirt of 70 micrometers) of a Bi alloy was further carried out to it by high speed gas flame thermal spraying aluminum-11%Si-0.3% after that.

[0037]The subsequent process manufactured the aluminum alloy made heat exchanger according to working example 1. Even if it did a 5000h neutral salt spray test, breakthrough foods were not generated at all in a 0.4-mm thick tube material.

[0038]Thermal spraying of the aluminum alloy wire (1.6mmphi) which becomes a 200-400 ** tube just behind the extrusion of working example 3 pure aluminium

(aluminum:99.9wt%) from aluminum-11%Si-5%Zn-0.3%Bi was carried out by electric arc spraying.

[0039]The subsequent process manufactured the aluminum alloy made heat exchanger according to working example 1. Even if it did a 5000h neutral salt spray test, breakthrough foods were not generated at all in a 0.4-mm thick tube material.

[0040]Thermal spraying of (the particle size undershirt of 70 micrometers) was carried out for the aluminum alloy powder which becomes a 200-400 ** tube just behind the extrusion of working example 4 pure aluminium (aluminum:99.9wt%) from a Bi alloy aluminum-11%Si-5%Zn-0.3% by high speed gas flame thermal spraying.

[0041]The subsequent process manufactured the aluminum alloy made heat exchanger according to working example 1. Even if it did a 5000h neutral salt spray test, breakthrough foods were not generated at all in a 0.4-mm thick tube material.

[0042]Once having dried and preheating the tube material made from working example 5 aluminum alloy (extrusion flattened tube) with an arc and gas flame at 200-400 ** after water cooling, even if it performed above-mentioned working example 1-4, it checked that the completely same result was obtained.

[0043]The interval of regrinding by paper polish of a roll in the cold rolling process of each working example was extended several times, and it was admitted that the endurance of a roll was improving.

[0044]It was admitted that the endurance (hour of use until it discards) of the louver cutter in each working example was also extended several times.

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[Translation done.]

WRITTEN AMENDMENT

---------- [A Written Amendment]
[Filing date]Heisei 6(1994) June 20
[Amendment 1]
[Document to be Amended]Description
[Item(s) to be Amended]0002
[Method of Amendment]Change
[Proposed Amendment]
[0002]
[Description of the Prior Art]The conventional aluminum alloy made heat exchanger to the tube material which consists of raise in basic wages material of aluminum (JISA1050, JIS A1100) or an aluminum alloy (aluminum-Mn) by which extrusion molding was carried out. Make aluminum-Mn alloy into a core material, use Si for wax material aluminum-6 to 15%, and both are cold-rolled between heat from a clad sheet, It was considered as the brazing sheet, the fabrication of the fin material which consists of a tube which carried out Zn thermal spraying, and a brazing sheet was carried out, and the back with a group had joined between headers to the tube of an aluminum alloy, and between fins and a tube by the flux brazing method or atmosphere brazing with the jig.
[Amendment 2]
[Document to be Amended]Description
[Item(s) to be Amended]0003
[Method of Amendment]Change
[Proposed Amendment]
[0003]However, since a fin is the brazing sheet in which the clad of high aluminum-Si alloy or the aluminum-Si-Zn alloy of hardness was carried out to the surface in this conventional method, In the rolling process, especially cold rolling process from an ingot clad sheet of a brazing sheet, wear of a reduction roll is intense, and. When processing a brazing sheet into the fin of a heat exchanger, the abrasion life of the louver cutter which carries out shearing of the louver formed in a fin is dramatically short, and the manufacturing cost of an aluminum alloy made heat exchanger becomes high.
[Amendment 3]

[Document to be Amended]Description
[Item(s) to be Amended]0020
[Method of Amendment]Change
[Proposed Amendment]
[0020]Methods of carrying out thermal spraying of the wax material to BEACHUBU may include the method of carrying out thermal spraying of the above-mentioned after alloy powder, and the method of carrying out thermal spraying of the wire of the above-mentioned alloy, and any may be sufficient. Any of flame spraying, high speed gas flame thermal spraying, and electric arc spraying may be sufficient.
[Amendment 4]
[Document to be Amended]Description
[Item(s) to be Amended]0025
[Method of Amendment]Change
[Proposed Amendment]
[0025]BEAFIN with a thickness of 0.05-0.3 mm manufactured by cold rolling etc., The tube material and BEAFIN by which it was fabricated by the fin configuration which has a louver with a louver cutter, and wax material was covered with the above-mentioned spraying process using a jig After [ with a group ], By the flux brazing method or the atmosphere brazing method, between headers is joined to a fin, and between tubes and a tube, and it is completed as an aluminum alloy made heat exchanger.
[Amendment 5]
[Document to be Amended]Description
[Item(s) to be Amended]0029
[Method of Amendment]Change
[Proposed Amendment]
[0029]When carrying out thermal spraying of the wax material of an aluminum-Si-Bi alloy after carrying out thermal spraying of the Zn to the surface of the tube of the extruded raise in basic wages material, into the temperature up of a brazing process, Zn sprayed layers fuse, are diffused in a raise in basic wages tube material, and form an effective Zn diffused layer in a tube surface on corrosion prevention. When carrying out thermal spraying of the wax material of an aluminum-Si-Zn-Bi alloy to the surface of the tube of the extruded raise in basic wages material at once, Zn in wax material is spread in a raise in basic wages fin material in a temperature rise process, and an effective Zn diffused layer is formed on corrosion prevention.
[Amendment 6]

[Document to be Amended]Description
[Item(s) to be Amended]0047
[Method of Amendment]Change
[Proposed Amendment]
[0047](3) Since a fin is the soft raise in basic wages material of aluminum-Mn alloy or an aluminum-Mn-Zn alloy, wear of the reduction roll of the rolling process from an ingot, especially a cold rolling process is ****(ed) sharply, and an endurance life improves sharply, and. The endurance of the louver cutter at the time of louver processing of the heat-exchanger-fins material (0.05-0.3-mm thickness) which consists of brazing sheets can improve preeminently, and a manufacturing cost can be reduced.

[Translation done.]

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最終頁に続く

(54)【発明の名称】　アルミニウム合金製熱交換器およびその製造方法

(57)【要約】

【目的】　製造コストが低減され、チューブ材とフィンの接合強度と耐食性に優れたアルミニウム合金製熱交換器を提供する。

【構成】　表面にＺｎを溶射した後、ろう材を溶射した皮膜を有するアルミニウムまたはアルミニウム合金からなるチューブ材に、アルミニウム合金からなるベアフィンを、フラックスろう付または雰囲気ろう付により接合したアルミニウム合金製熱交換器であって、ろう材の合金組成が、Ｓｉ：６～１３ｗｔ％、Ｂｉ：０．１～０．５ｗｔ％、残部がＡｌおよび不可避的不純分からなるアルミニウム合金であり、ベアフィンのアルミニウム合金組成が、Ｍｎ：０．５～５ｗｔ％、残部がＡｌおよび不可避的不純分からなるアルミニウム合金またはＭｎ：０．５～５ｗｔ％、Ｚｎ：０．５～８ｗｔ％、残部がＡｌおよび不可避的不純分からなるアルミニウム合金であることを特徴とするアルミニウム合金製熱交換器。

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【特許請求の範囲】

【請求項１】　表面にＺｎを溶射した後、ろう材を溶射した皮膜を有するアルミニウムまたはアルミニウム合金からなるチューブ材に、アルミニウム合金からなるベアフィンを、フラックスろう付または雰囲気ろう付により接合したアルミニウム合金製熱交換器であって、ろう材の合金組成が、Ｓｉ：６～１３ｗｔ％、Ｂｉ：０．１～０．５ｗｔ％、残部がＡｌおよび不可避的不純分からなるアルミニウム合金であり、ベアフィンのアルミニウム合金組成が、Ｍｎ：０．５～５ｗｔ％、残部がＡｌおよび不可避的不純分からなるアルミニウム合金、またはＭｎ：０．５～５ｗｔ％、Ｚｎ：０．５～８ｗｔ％、残部がＡｌおよび不可避的不純分からなるアルミニウム合金であることを特徴とするアルミニウム合金製熱交換器。

【請求項２】　表面にろう材を溶射した皮膜を有するアルミニウムまたはアルミニウム合金からなるチューブ材に、アルミニウム合金からなるベアフィンを、フラックスろう付または雰囲気ろう付により接合したアルミニウム合金製熱交換器であって、ろう材の合金組成が、Ｓｉ：６～１３ｗｔ％、Ｚｎ：０．５～８ｗｔ％、Ｂｉ：０．１～０．５ｗｔ％、残部がＡｌおよび不可避的不純分からなるアルミニウム合金であり、ベアフィンのアルミニウム合金組成が、Ｍｎ：０．５～５ｗｔ％、残部がＡｌおよび不可避的不純分からなるアルミニウム合金、またはＭｎ：０．５～５ｗｔ％、Ｚｎ：０．５～８ｗｔ％、残部がＡｌおよび不可避的不純分からなるアルミニウム合金であることを特徴とするアルミニウム合金製熱交換器。

【請求項３】　アルミニウムまたはアルミニウム合金からなるチューブの表面にＺｎを溶射した後、合金組成がＳｉ：６～１３ｗｔ％、Ｂｉ：０．１～０．５ｗｔ％、残部がＡｌおよび不可避的不純分からなるアルミニウム合金からなるろう材を溶射し、合金組成が、Ｍｎ：０．５～５ｗｔ％、残部がＡｌおよび不可避的不純分であるアルミニウム合金、またはＭｎ：０．５～５ｗｔ％、Ｚｎ：０．５～８ｗｔ％、残部がＡｌおよび不可避的不純分であるアルミニウム合金からなるベアフィンを、組付た後、フラックスろう付または雰囲気ろう付して接合したことを特徴とするアルミニウム合金製熱交換器の製造方法。

【請求項４】　アルミニウムまたはアルミニウム合金からなるチューブの表面に、合金組成がＳｉ：６～１３ｗｔ％、Ｚｎ：０．５～８ｗｔ％、Ｂｉ：０．１～０．５ｗｔ％、残部がＡｌおよび不可避的不純分からなるアルミニウム合金からなるろう材を溶射し、合金組成が、Ｍｎ：０．５～５ｗｔ％、残部がＡｌおよび不可避的不純分であるアルミニウム合金、またはＭｎ：０．５～５ｗｔ％、Ｚｎ：０．５～８ｗｔ％、残部がＡｌおよび不可避的不純分であるアルミニウム合金からなるベアフィンを、組付た後、フラックスろう付または雰囲気ろう付して接合したことを特徴とするアルミニウム合金製熱交換器の製造方法。

2

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、フラックスろう付法または雰囲気ろう付により製造されるアルミニウム合金製熱交換器に関する物であり、本発明のアルミニウム合金製熱交換器は、カークーラー用熱交換器、産業用熱交換器などに広く適用されるものである。

【０００２】

【従来の技術】従来のアルミニウム合金製熱交換器は、押出成形されたアルミニウム（ＪＩＳＡ１０５０，ＪＩＳ　Ａ１１００）またはアルミニウム合金（Ａｌ－Ｍｎ）のベア材からなるチューブ材に、Ａｌ－Ｍｎ合金を芯材とし、ろう材にＡｌ－６～１５％Ｓｉ－０．５～３％Ｍｇ合金またはＡｌ－７～１５％Ｓｉ合金を用い、両者を合せ板から熱間、冷間圧延して、ブレージングシートとし、Ｚｎ溶射したチューブとブレージングシートからなるフィン材を切組し治具にて組付後、フラックスろう付法または雰囲気ろう付によりアルミニウム合金のチューブとフィン間、チューブとヘッダ間を接合していた。

【０００３】しかし、この従来法ではフィンは硬度の高いＡｌ－Ｓｉ－Ｍｇ合金またはＡｌ－Ｓｉ－Ｍｇ－Ｚｎ合金が表面にクラッドされたブレージングシートであるため、ブレージングシートのインゴット合せ板からの圧延過程、特に冷間圧延過程において圧延ロールの摩耗が激しいと共に、ブレージングシートを熱交換器のフィンに加工する際、フィンに形成されるルーバを剪断加工するルーバカッタの摩耗寿命が非常に短く、アルミニウム合金製熱交換器の製造コストが高くなる。

【０００４】また、アルミニウムまたはアルミニウム合金のチューブの表面に特定範囲のＡｌ－Ｚｎ－Ｓｉ合金の皮膜を形成し、ろう材を有しないフィンを組付けて、フラックスろう付するアルミニウム製熱交換器の製造方法が知られている（特開平１－１０７９６１号）。

【０００５】しかしながら、この従来技術では、ろう材のぬれ性、流動性が充分でないため、接合の強度がやや不足するという問題点があった。

【０００６】

【発明が解決しようとする課題】本発明は、上記従来技術の問題点を解消すべくなされたものであり、本発明の目的は、ブレージングシートのインゴット合せ板からの圧延過程における圧延ロールの寿命を伸ばし、フィンに形成されるルーバを剪断加工するルーバカッタの摩耗寿命を伸ばすことによりアルミニウム合金製熱交換器の製造コストを低減し、チューブ材とフィンの接合強度と耐食性に優れたアルミニウム合金製熱交換器を提供することである。

【０００７】

【課題を解決するための手段および作用】本発明者らは、上記課題を解決すべく鋭意研究を重ねた結果、ろう材としてチューブ材表面にＢｉを含む特定の合金を溶射し、特定のアルミニウム合金のベア材からなるフィンを組付後、フラックスろう付または雰囲気ろう付すればよいことを見いだし本発明を完成するに至った。

【０００８】すなわち本発明は、

（１）表面にＺｎを溶射した後、ろう材を溶射した皮膜を有するアルミニウムまたはアルミニウム合金からなるチューブ材に、アルミニウム合金からなるベアフィンを、フラックスろう付または雰囲気ろう付により接合したアルミニウム合金製熱交換器であって、ろう材の合金組成が、Ｓｉ：６～１３ｗｔ％、Ｂｉ：０．１～０．５ｗｔ％、残部がＡｌおよび不可避的不純分からなるアルミニウム合金であり、ベアフィンのアルミニウム合金組成が、Ｍｎ：０．５～５ｗｔ％、残部がＡｌおよび不可避的不純分からなるアルミニウム合金、またはＭｎ：０．５～５ｗｔ％、Ｚｎ：０．５～８ｗｔ％、残部がＡｌおよび不可避的不純分からなるアルミニウム合金であることを特徴とするアルミニウム合金製熱交換器。

【０００９】（２）表面にろう材を溶射した皮膜を有するアルミニウムまたはアルミニウム合金からなるチューブ材に、アルミニウム合金からなるベアフィンを、フラックスろう付または雰囲気ろう付により接合したアルミニウム合金製熱交換器であって、ろう材の合金組成が、Ｓｉ：６～１３ｗｔ％、Ｚｎ：０．５～８ｗｔ％、Ｂｉ：０．１～０．５ｗｔ％、残部がＡｌおよび不可避的不純分からなるアルミニウム合金であり、ベアフィンのアルミニウム合金組成が、Ｍｎ：０．５～５ｗｔ％、残部がＡｌおよび不可避的不純分からなるアルミニウム合金、またはＭｎ：０．５～５ｗｔ％、Ｚｎ：０．５～８ｗｔ％、残部がＡｌおよび不可避的不純分からなるアルミニウム合金であることを特徴とするアルミニウム合金製熱交換器。

【００１０】（３）アルミニウムまたはアルミニウム合金からなるチューブの表面にＺｎを溶射した後、合金組成がＳｉ：６～１３ｗｔ％、Ｂｉ：０．１～０．５ｗｔ％、残部がＡｌおよび不可避的不純分からなるアルミニウム合金からなるろう材を溶射し、合金組成が、Ｍｎ：０．５～５ｗｔ％、残部がＡｌおよび不可避的不純分であるアルミニウム合金、またはＭｎ：０．５～５ｗｔ％、Ｚｎ：０．５～８ｗｔ％、残部がＡｌおよび不可避的不純分であるアルミニウム合金からなるベアフィンを、組付た後、フラックスろう付または雰囲気ろう付して接合したことを特徴とするアルミニウム合金製熱交換器の製造方法。

【００１１】（４）アルミニウムまたはアルミニウム合金からなるチューブの表面に、合金組成がＳｉ：６～１３ｗｔ％、Ｚｎ：０．５～８ｗｔ％、Ｂｉ：０．１～０．５ｗｔ％、残部がＡｌおよび不可避的不純分からなるアルミニウム合金からなるろう材を溶射し、合金組成が、Ｍｎ：０．５～５ｗｔ％、残部がＡｌおよび不可避的不純分であるアルミニウム合金、またはＭｎ：０．５～５ｗｔ％、Ｚｎ：０．５～８ｗｔ％、残部がＡｌおよび不可避的不純分であるアルミニウム合金からなるベアフィンを、組付た後、フラックスろう付または雰囲気ろう付して接合したことを特徴とするアルミニウム合金製熱交換器の製造方法。を要旨とするものである。

【００１２】本発明において、チューブ材として用いられるものは、ＪＩＳ　Ａ１０５０，ＪＩＳ　Ａ１１００等のアルミニウムまたはＭｎ等を添加したアルミニウム合金が挙げられるが、これらに限定されるものではない。チューブは、アルミニウムまたはアルミニウム合金を、押出し成形法により成形される。

【００１３】本発明は、チューブ材の製造方法により、押出されたベア材のチューブの表面にＺｎを溶射した後、Ａｌ－Ｓｉ－Ｂｉ合金のろう材を溶射する場合と（請求項１、３）、押出されたベア材のチューブの表面にＡｌ－Ｓｉ－Ｚｎ－Ｂｉ合金のろう材を１回で溶射する場合（請求項２、４）とに分けられる。

【００１４】チューブへ、Ｚｎを溶射するには、アルミニウムまたはアルミニウム合金の押出し扁平管の押出し直後に溶射すればよく、溶射前処理としての予熱は不要である。溶射方法は、フレーム溶射、高速ガス炎溶射、アーク溶射のいずれでもよい。Ｚｎの溶射は、目付量が５～２０ｇ／$m^2$となるように溶射量を調整する。

【００１５】本発明において、フィン材は、ろう材（硬いＡｌ－Ｓｉ合金）がクラッドされていないベア材を用いるため、ろう材はチューブ上に溶射法によって被覆させる。アルミニウムまたはアルミニウム合金のチューブの表面に溶射されるろう材は、上記のように特定の範囲の、Ａｌ－Ｓｉ－Ｂｉ合金またはＡｌ－Ｓｉ－Ｂｉ－Ｚｎ合金であり、各成分の作用と配合割合の限定理由は、以下のとおりである。

【００１６】・Ｓｉ

Ａｌの融点を下げ、溶融後の流動性を良好にし、ろう付性を向上させる。６ｗｔ％～１３ｗｔ％の範囲を外れると、Ａｌ－Ｓｉ合金の融点が高くなると共に、溶融後の流動性が低下し、ろう付性が低下する。

【００１７】・Ｂｉ

溶融後のＡｌ－Ｓｉ合金のぬれ性が向上し、Ａｌ－Ｓｉ合金ろう材の流動性が向上するため、ろう付性がよくなる。０．１ｗｔ％未満では、Ａｌ－Ｓｉ合金溶射材からなるろう材のぬれ性、流動性が低下するため好ましくない。また、０．５ｗｔ％を超えて添加しても、Ａｌ－Ｓｉ合金溶射材からなるろう材の流動性およびぬれ性は向上しない。

【００１８】・Ｚｎ

ろう付加熱サイクル中に、熱交換器チューブの表層に拡散し、アルミニウム合金の孔食防止に極めて有効な亜鉛

拡散層を形成する。０．５ｗｔ％未満では、防食に有効な亜鉛拡散層が充分形成されず、８ｗｔ％を超えて添加すると、過大な亜鉛拡散層が形成されるため、かえって熱交換器の耐食寿命が低下するため好ましくない。

【００１９】チューブ（押出偏平管）へのろう材の溶射方法としては、押出機から押出されたチューブへ純Ｚｎを溶射後、さらにＡｌ－８～１３％Ｓｉ－０．１～０．５％Ｂｉ合金を溶射する方法と、押出されたチューブにＡｌ－８～１３％Ｓｉ－０．５～８％Ｚｎ－０．１～０．５％Ｂｉ合金を１回のみ溶射する二方法があるが、いずれも有効である。

【００２０】ベアフィンにろう材を溶射する方法としては、上記合金粉末を溶射する方法、上記合金のワイヤを溶射する方法があり、いずれでもよい。また、フレーム溶射、高速ガス炎溶射、アーク溶射のいずれでもよい。

【００２１】本発明に用いられるフィンは、Ａｌ－Ｍｎ合金又はＡｌ－Ｍｎ－Ｚｎ合金のベア材（ろう材がクラッドされていない裸材）である。ベアフィンのアルミニウム合金の成分の作用と配合割合の限定理由は、以下のとおりである。

【００２２】・Ｍｎ

硬さおよび強度が向上すると共に、ろう付加熱時のフィンの変形を防止できる。０．５ｗｔ％未満では、ろう付加熱時のフィンの変形が防止できず、５ｗｔ％を超えて添加すると強度が上りすぎてフィンの成形加工が困難になるため好ましくない。

【００２３】・Ｚｎ

フィンの腐食電位を下げ、チューブを陰極防食する作用がある。０．５ｗｔ％未満では、チューブを陰極防食するために充分な卑の電位とすることができず、８ｗｔ％を超えて添加しても、卑の電位が向上せず、フィンの自己腐食が激しくなり好ましくない。

【００２４】本発明の、フィンはろう材がクラッドされていないベア材であるため軟らかく、フィン材となるブレージングシートの製造工程の冷間圧延ロールの寿命が大幅に伸びると共に、フィン材となったブレージングシートのルーバ剪断加工に用いるルーバカッタの寿命が大幅に伸びるため、製造コストを大幅に下げることができる。

【００２５】冷間圧延等により製造された厚さ０．１～０．３mmのベアフィンは、ルーバカッタによりルーバを持つフィン形状に成形され、上記の溶射法によりろう材が被覆されたチューブ材とベアフィンとを治具を用いて組付後、フラックスろう付法または雰囲気ろう付法にて、フィンとチューブ間、チューブとヘッダ間が接合されアルミニウム合金製熱交換器として完成される。

【００２６】フラックスろう付で使用されるフラックスは、通常用いられるものであれば特に限定されないが、例えばＮａＣｌ、ＫＣｌ等の塩化物系、$KAlF_4$、$K_3AlF_6$等のフッ化物系が挙げられる。



【００２７】本発明における雰囲気ろう付法は、窒素ガス、アルゴンガスなどの不活性雰囲気中、加熱温度は５９０～６１０℃の範囲で、炉内圧力は０．１～７６０Ｔｏｒｒの範囲でろう付を行えばよい。

【００２８】フラックスろう付法および雰囲気ろう付法ともに、ろう付温度は５９０～６１０℃で行えばよく、ろう付熱サイクルを受けてろう材が溶融して、チューブとフィン間、チューブとヘッダ間にフィレットが形成され接合が完了する。その後必要に応じて化成処理、樹脂被覆処理が施される。

【００２９】押出されたベア材のチューブの表面にＺｎを溶射した後、Ａｌ－Ｓｉ－Ｂｉ合金のろう材を溶射する場合は、ろう付過程の昇温中にＺｎ溶射層は溶融し、ベアチューブ材中に拡散して、チューブ表面に防食上有効なＺｎ拡散層を形成する。押出されたベア材のチューブの表面にＡｌ－Ｓｉ－Ｚｎ－Ｂｉ合金のろう材を１回で溶射する場合は、昇温過程でろう材中のＺｎがベアフィン材中に拡散し、防食上有効なＺｎ層を形成する。

【００３０】なお、本発明のアルミニウム合金製熱交換器は、サーペンタイン型、パラレルフロー型、ドロンカップ（積層）型、その他各種型式の熱交換器に適用することができる。

【００３１】以下、実施例により本発明を詳細に説明するが、これらの実施例に限定されるものではない。

【００３２】

【実施例】

実施例１

純アルミニウム（Ａｌ：９９．９ｗｔ％）の押出直後の２００～４００℃のチューブ（押出偏平管）に、純Ｚｎワイヤ（１．６mmφ）をアーク溶射法により１０ｇ／$m^2$ 溶射し、その直後Ａｌ－１１％Ｓｉ－０．３％Ｂｉからなるアルミ合金ワイヤをアーク溶射法により目付量５０ｇ／$m^2$ 溶射した。

【００３３】別途作成されたベアフィン（Ａｌ－１％Ｍｎ－１％Ｚｎ）素材はルーバ加工され、上記のチューブと治具にて組付けた。組付けた熱交換器素材にフッ化アルミニウムのカリ塩からなるフラックスをスプレー塗布後、乾燥し、ノコロックろう付炉に挿入した。

【００３４】ろう付温度パターンは、常温から６０５℃まで昇温し５分間保持後冷却した。このろう付過程の昇温中にＺｎ溶射層は溶融し、チューブ材（Ａ１０５０）中に拡散し表面亜鉛濃度３％、拡散深さ１２０μmの亜鉛拡散層を形成した。この亜鉛拡散層はチューブ芯材（Ａ１０５０ｅｔｃの純アルミ）に比べ腐食電位が卑であり、塩水噴霧試験５０００ｈにて０．４mmの肉厚のチューブ材に貫通孔食は全く発生せず、チューブの孔食防止に極めて有効であった。

【００３５】また、ろう材（溶射材中のＡｌ－Ｓｉ－Ｂｉ）は５９０℃で溶融を開始し、６０５℃×５分のろう付保持時間で、チューブ－フィン間、チューブ－ヘッダ

間に強度上十分な大きさのフィレットが形成され、ろう付部のろう切れも発生しなかった。

【００３６】実施例２

純アルミニウム（Ａｌ：９９．９ｗｔ％）の押出直後の２００～４００℃のチューブに、純Ｚｎワイヤ（１．６ｍｍφ）をアーク溶射し、さらにその後Ａｌ－１１％Ｓｉ－０．３％Ｂｉ合金の粉末（粒度７０μｍアンダー）を高速ガス炎溶射により溶射した。

【００３７】その後の工程は実施例１に準じ、アルミニウム合金製熱交換器を製造した。５０００ｈ塩水噴霧試験を行っても、０．４ｍｍの肉厚のチューブ材に貫通孔食は全く発生しなかった。

【００３８】実施例３

純アルミニウム（Ａｌ：９９．９ｗｔ％）の押出直後の２００～４００℃のチューブに、Ａｌ－１１％Ｓｉ－５％Ｚｎ－０．３％ＢｉからなるＡｌ合金ワイヤ（１．６ｍｍφ）をアーク溶射により溶射した。

【００３９】その後の工程は実施例１に準じ、アルミニウム合金製熱交換器を製造した。５０００ｈ塩水噴霧試験を行っても、０．４ｍｍの肉厚のチューブ材に貫通孔食は全く発生しなかった。

【００４０】実施例４

純アルミニウム（Ａｌ：９９．９ｗｔ％）の押出直後の２００～４００℃のチューブに、Ａｌ－１１％Ｓｉ－５％Ｚｎ－０．３％Ｂｉ合金からなるアルミニウム合金粉末を（粒度７０μｍアンダー）を高速ガス炎溶射で溶射した。

【００４１】その後の工程は実施例１に準じ、アルミニウム合金製熱交換器を製造した。５０００ｈ塩水噴霧試験を行っても、０．４ｍｍの肉厚のチューブ材に貫通孔食は全く発生しなかった。

【００４２】実施例５

＊アルミニウム合金製のチューブ材（押出偏平管）を一旦水冷後、乾燥し、２００～４００℃で、アーク、ガス炎にて予熱した後、上記実施例１～４を行っても全く同じ結果が得られることを確認した。

【００４３】各実施例の冷間圧延工程における、ロールのペーパー研磨による再研磨の間隔が数倍に伸び、ロールの耐久性が向上していることが認められた。

【００４４】また、各実施例におけるルーバカッタの耐久性（廃棄するまでの使用時間）も数倍に伸びたことが認められた。

【００４５】

【発明の効果】本発明のアルミニウム合金製熱交換器は、以下のような優れた効果を有する。

（１）チューブ材の表面に溶射されるろう材にＢｉが含まれているため、ろう材の流動性、ぬれ性が改善されるため、チューブーフィン間、チューブーヘッダ間に充分なフィレットが形成され、強度、耐圧上充分な接合がなされる。

【００４６】（２）ベアフィンに溶射されたＺｎまたはろう材中のＺｎは、フラックスろう付または雰囲気ろう付過程における熱サイクルによりチューブ材中に拡散し、チューブの耐食性向上に抜群の効果のあるＺｎ拡散層を形成する。

【００４７】（３）フィンがＡｌ－Ｍｎ合金またはＡｌ－Ｍｎ－Ｚｎ合金の軟らかなベア材であるため、インゴットからの圧延過程特に冷間圧延過程の圧延ロールの摩耗が大巾に削限され耐久寿命が大巾に向上すると共に、ブレージングシートからなる熱交換器フィン材（０．１～０．３ｍｍ厚）のルーバ加工時のルーバカッタの耐久性が抜群に向上し、製造コストを低減することができる。

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【手続補正書】

【提出日】平成６年６月２０日

【手続補正１】

【補正対象書類名】明細書

【補正対象項目名】０００２

【補正方法】変更

【補正内容】

【０００２】

【従来の技術】従来のアルミニウム合金製熱交換器は、押出成形されたアルミニウム（ＪＩＳＡ１０５０，ＪＩＳ　Ａ１１００）またはアルミニウム合金（Ａｌ－Ｍｎ）のベア材からなるチューブ材に、Ａｌ－Ｍｎ合金を芯材とし、ろう材にＡｌ－６～１５％Ｓｉを用い、両者を合せ板から熱間、冷間圧延して、ブレージングシートとし、Ｚｎ溶射したチューブとブレージングシートからなるフィン材を互組し治具にて組付後、フラックスろう付法または雰囲気ろう付によりアルミニウム合金のチューブとフィン間、チューブとヘッダ間を接合していた。

【手続補正２】

【補正対象書類名】明細書

【補正対象項目名】０００３

【補正方法】変更

【補正内容】

【０００３】しかし、この従来法ではフィンは硬度の高いＡｌ－Ｓｉ合金またはＡｌ－Ｓｉ－Ｚｎ合金が表面にクラッドされたブレージングシートであるため、ブレージングシートのインゴット合せ板からの圧延過程、特に冷間圧延過程において圧延ロールの摩耗が激しいと共に、ブレージングシートを熱交換器のフィンに加工する際、フィンに形成されるルーバを剪断加工するルーバカッタの摩耗寿命が非常に短く、アルミニウム合金製熱交

換器の製造コストが高くなる。
【手続補正３】
【補正対象書類名】明細書
【補正対象項目名】００２０
【補正方法】変更
【補正内容】
【００２０】ベアチューブにろう材を溶射する方法としては、上記合金粉末を溶射する方法、上記合金のワイヤを溶射する方法があり、いずれでもよい。また、フレーム溶射、高速ガス炎溶射、アーク溶射のいずれでもよい。
【手続補正４】
【補正対象書類名】明細書
【補正対象項目名】００２５
【補正方法】変更
【補正内容】
【００２５】冷間圧延等により製造された厚さ０．０５～０．３mmのベアフィンは、ルーバカッタによりルーバを持つフィン形状に成形され、上記の溶射法によりろう材が被覆されたチューブ材とベアフィンとを治具を用いて組付後、フラックスろう付法または雰囲気ろう付法にて、フィンとチューブ間、チューブとヘッダ間が接合されアルミニウム合金製熱交換器として完成される。
【手続補正５】
【補正対象書類名】明細書
＊【補正対象項目名】００２９
【補正方法】変更
【補正内容】
【００２９】押出されたベア材のチューブの表面にＺｎを溶射した後、Ａｌ－Ｓｉ－Ｂｉ合金のろう材を溶射する場合は、ろう付過程の昇温中にＺｎ溶射層は溶融し、ベアチューブ材中に拡散して、チューブ表面に防食上有効なＺｎ拡散層を形成する。押出されたベア材のチューブの表面にＡｌ－Ｓｉ－Ｚｎ－Ｂｉ合金のろう材を１回で溶射する場合は、昇温過程でろう材中のＺｎがベアフィン材中に拡散し、防食上有効なＺｎ拡散層を形成する。
【手続補正６】
【補正対象書類名】明細書
【補正対象項目名】００４７
【補正方法】変更
【補正内容】
【００４７】（３）フィンがＡｌ－Ｍｎ合金またはＡｌ－Ｍｎ－Ｚｎ合金の軟らかなベア材であるため、インゴットからの圧延過程特に冷間圧延過程の圧延ロールの摩耗が大巾に削限され耐久寿命が大巾に向上すると共に、ブレージングシートからなる熱交換器フィン材（０．０５～０．３mm厚）のルーバ加工時のルーバカッタの耐久性が抜群に向上し、製造コストを低減することができる。

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フロントページの続き

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